

Application No. 10/588,292  
Reply to Office Action of October 10, 2008

IN THE DRAWINGS

The attached sheets of drawings includes changes to Figs. 1-7. These sheets, which include Figs. 1-7, replace the original sheets including Figs. 1-7.

Attachment: Replacement Sheet

SUPPORT FOR THE AMENDMENTS

The paragraph beginning on page 28, last line is amended to correct two obvious clerical errors. There is no element “Zu.” This must represent “Zn” as corrected.

The paragraph beginning on page 30, line 10, is amended to correct a clerical error wherein the Figures were mistakenly referenced. The subject matter of the paragraph now correctly describes the Figures.

Support for the amendment of Claim 1 is found on page 5, lines 3-10, and page 20, lines 9-15, and page 21, line 10 and page 23, line 3, of the specification.

Claims 2-5 are amended to have proper antecedent basis to Claim 1.

Support for the amendment of Claim 6 is found on page 29, lines 1-3, in the specification and in Claim 11.

Support for the amendment of Claim 8 is found on page 30, lines 5-9, in the specification.

Claim 11 is canceled.

Support for the amendment of Claim 14 is found on page 20, lines 9-15, and page 21, line 10 and page 23, line 3, of the specification.

Support for the amendment of Claim 12 is found on page 29, lines 3-5, in the specification.

Claim 16 is new and is supported on page 29, lines 5-7, in the specification.

Claim 17 is new and is supported on page 50, Table 1, especially Example 9, and page 28, lines 6-9, in the specification.

Claim 18 is new and is supported by Claim 2.

No new matter is believed added to this application by entry of this amendment.

Upon entry of this amendment, Claims 1-10 and 12-18 are active.

REMARKS/ARGUMENTS

The claimed invention is directed to a light emitting device in which a semiconductor light emitting element is combined with a red phosphor, a lighting system using the device and an image display unit having the device. In order to improve the performance of a light emitting device of this type, a red phosphor having a high excitation emission efficiency in the near ultraviolet region is sought.

The claimed invention addresses this problem by providing a light emitting device having a red phosphor as described in Claim 1 and claims dependent thereon. Applicants have surprisingly determined that the emission efficiency of a red phosphor is significantly improved when the structural environment of the europium ion is controlled to a specific crystal form.

Applicants have described the significant influence of the crystal structure on page 8, lines 7-22, as follows:

In these compounds, an absorption spectrum of a complex molecule approximately agrees with that of the ligand. However, when these compounds are in a state in which an intermolecular interaction is possible, absorption characteristics thereof do not necessarily agree with those in a molecular state, that is to say, in a dilute solution state, and a shift of an absorption peak to a longer wave length and enlargement of the spectrum width are observed. The absorption peak value and absorption form of the absorption spectrum depend on the state of the intermolecular interaction and the surrounding environmental state, and the excitation spectrum becomes flat and broad in width by obtaining the sufficiently broad absorption spectrum. In addition, in some state of the intermolecular interaction, the excitation energy absorbed by the ligand has been known to transfer between molecules, different from the case of the molecular state.

Furthermore on page 9, lines 13-18, Applicants have described that:

Consequently, in order to enhance the emission efficiency, it is necessary to remove the impurities, or to select the optimum ligand or the environment such as a crystalline state. Even for the same compound, the emission intensity is significantly different in some cases depending on the surrounding environmental state.

Applicants have supported this statement in the Examples of the specification.

Specifically comparison of Inventive Example 2 with Comparative Example 2, Inventive Example 5 with Comparative Example 3, and Inventive Example 9 with Comparative Example 4 show the importance of the crystal environment and the significant improvement in emission performance obtained with the red phosphors according to the claimed invention. The data for these examples are presented below for the Examiner's convenience.

Example	Formula	L/H	Emission Efficiency
2	Eu(TTA) <sub>3</sub> Phen	83.9	47.6
Comp. 2	Eu(TTA) <sub>3</sub> Phen	50.2	29.4
5	Eu(2NFA) <sub>3</sub> Phen	86.4	39.2
Comp. 3	Eu(2NFA) <sub>3</sub> Phen	53.8	6.8
9	Eu(2NFA) <sub>3</sub> DPPhen	76.2	37.4
Comp. 4	Eu(2NFA) <sub>3</sub> DPPhen	58.8	26.4

As indicated in the table, the inventive examples having the claimed crystal form have flatter and stronger absorption in the near ultraviolet region (L/H) and have significantly improved emission efficiency even though the molecules have the same formula. No such light emitting device having the red phosphor according to the claimed invention is disclosed or suggested in the cited references.

Applicants wish to thank Examiner Koslow for the useful, courteous and productive discussion of this application with Applicants' U.S. representative on February 3, 2009. At that time Applicants U.S. representative discussed the significant improvement in emission efficiency obtained with the specific crystal structure as described in the claimed invention.

The methods to prepare the comparable Europium complexes of the cited references were contrasted to those of the claimed invention and Applicants' U.S. representative showed that none of the cited references employed the methods described in the claimed invention and therefore could not have the same crystal structure. Amendments to the claims to more clearly describe the invention were discussed. Applicants wish to thank Examiner Koslow for her suggestions.

Applicants respectfully note that Claims 1 and 14 are herein amended to include the description that the red phosphor consists of a crystal state, having the properties described in the claims. Applicants have described on page 28, lines 8-9, that "it is preferred to be used as fine particles in the crystal state which are long in exciton life." Applicants have determined that in such crystalline state, the molecules exhibit a regular alignment and an excitation band shifts to a longer wavelength. It can therefore function as a phosphor for white LED.

The rejection of Claims 14 and 15 under 35 U.S.C. 102(b) over Imanishi et al. (U.S. 2003/0106460), Byers et al. (U.S. 5,006,503) and Kleinerman (U.S. 3,398,099) is respectfully traversed.

Applicants respectfully submit that even though compounds of the same formula are described, none of the cited references describes a red phosphor consisting of a triclinic crystal structure and none of the cited references prepare the red phosphor as described in the claimed invention. The following chart compares synthesis parameters of the references with those of the present invention which are used to obtain the crystal structure having the claimed spectral properties.

Example	Formula	Solvent	Temp.	Base	Comments
Inv. 8	Eu(2NFA) <sub>3</sub> (TPPO) <sub>2</sub>	IPA/EtOH	Room	2,2'Iminodiethanol	2 hours addition
'460 Comp. 3	Same as Inv. 8	EtOH	40°C	NaOH	No time given
Inv. 1	Eu(TTA) <sub>3</sub> (TPPO) <sub>2</sub>	IPA	Room	2,2'Iminodiethanol	2 hours addition
'503	Same as Inv. 1	EtOH	?	None	?
Inv. 2	Eu(TTA) <sub>3</sub> Phen	EtOH	Room	2,2'Iminodiethanol	4 hours addition
'099	Same as Inv. 2	DMSO/Water	Heat(?)	None	Recrystallize from methanol
Inv. 6	Eu(DBM) <sub>3</sub> Phen	EtOH	Room	2,2'Iminodiethanol	2 hours addition

Applicants respectfully submit that none of the cited references describe the red phosphor having a triclinic crystal structure and having a minimum emission intensity within the excitation wavelength range of 380 nm to 410 nm of 65% or more and an emission efficiency at 400 nm of 20% or more. Accordingly, none of the cited references can anticipate the claimed invention.

Moreover, none of the cited references prepares the red phosphor in the manner described by Applicants and therefore does not have the claimed crystal structure. None of the cited references recognizes the importance of crystal structure with regard to emission efficiency and none provide motivation that would have led one of ordinary skill in the art at the time of invention to the claimed invention with the significant improvement in emission efficiency obtained in the present invention. Therefore none of the cited references can render the claimed invention obvious.

In view of all the above, Applicants respectfully request withdrawal of the rejection of Claims 14 and 15 under 35 U.S.C. 102(b) over Imanishi, Byers and Kleinerman.

The rejection of Claims 1-5, 7, 10, 11 and 13-15 under 35 U.S.C. 102(b) over Boerner et al. (U.S. 6,051,925) is respectfully traversed.

Boerner describes a diode-addressed color display containing an UV-diode and a phosphor for luminous representations, etc. The Office has cited this reference as showing the Eu complexes described in Inventive Examples 2 and 9 in the specification.

Applicants respectfully submit that Boerner is silent with respect to crystal structure and provides no guidance or motivation that would have led one of ordinary skill in the art to the claimed invention with respect to crystal structure to obtain the significant improvement in emission efficiency as in the present invention. Moreover, as shown by comparison in the following chart, Boerner does not prepare the cited structures using a method as described by Applicants and therefore does not obtain the claimed triclinic crystal structure.

Sample	Formula	Solvent	Temp.	Base
Inv. 2	Eu(TTA) <sub>3</sub> Phen	EtOH	Room	2,2’Iminodiethanol
‘925 Ex. 2	Same as Inv. 2	EtOH	60°C	NaOCH <sub>3</sub>
Inv. 9	Eu(2NFA) <sub>3</sub> DPPhen	EtOH	Room	2,2’Iminodiethanol
‘925 Ex. 3	Same as Inv. 9	EtOH	EtOH reflux	NaOCH <sub>3</sub>

Applicants also note that Boerner first isolates a water complex of the Eu salt and then in a second reaction replaces the water with the neutral ligand. Applicants therefore, respectfully submit that the cited reference does not describe or suggest the red phosphor having a triclinic crystal structure and spectral properties according to the claimed invention. In addition, the reference does not describe a method of preparation of the red phosphor which would provide the described crystal structure. Therefore, the cited reference can neither anticipate nor render the claimed invention obvious and withdrawal of the rejection of Claims 1-5, 7, 10, 11 and 13-15 under 35 U.S.C. 102(b) over Boerner is respectfully requested.

The rejection of Claims 1-7, 8, 9, 11, 12, 14 and 15 under 35 U.S.C. 102(a) over JP 2004-356358 or JP 2004-352928 (equivalent to EP 1,641,048)) is respectfully traversed.

The cited references describe a light emitting device having a light emitter and a fluorescent material containing at least one fluorescent material. Specific examples of Eu

complexes with neutral ligands are shown in [0040] of this reference as cited by the Office. However, nowhere is a specific crystal structure described or suggested and nowhere does any of the cited references recognize or suggest that emission efficiency can be significantly improved by obtaining the presently claimed crystal structure. Furthermore, none of the cited references describes preparation of the Eu complexes and therefore none provide motivation that would have led one of ordinary skill in the art, at the time of invention to the claimed invention. Accordingly, withdrawal of the rejection of Claims 1-7, 8, 9, 11, 12, 14 and 15 under 35 U.S.C. 102(a) over JP 2004-356358 or JP 2004-352928 (equivalent to EP 1,641,048)) is respectfully requested.

The rejection of Claims 1-7, 9 10 and 12-15 under 35 U.S.C. 102(a) or 35 U.S.C. 102(e) over Shimomura et al. (U.S. 2004/0251809 or U.S. 7,189,340) is respectfully traversed. Applicants note that the cited references are related as pre-Grant publication and patent therefrom.

The Office has cited Example 8 in both references as describing Eu(TTA)<sub>3</sub>(TPPO)<sub>2</sub> which is described as Example 1 in the claimed invention. Applicants respectfully note that neither cited reference discloses or suggests the specific crystal structure described in the claimed invention and comparison of the method of preparation of the cited references to the method employed in the present invention shows that the claimed crystal structure is not obtained in the references.

Sample	Formula	Solvent	Temp.	Base
Inv. 1	Eu(TTA) <sub>3</sub> (TPPO) <sub>2</sub>	IPA	Room	2,2'Iminodiethanol
Ref. Ex. 8	Same	EtOH/water	60-70°	NaOH

In view of the above, Applicants respectfully submit that neither cited reference can anticipate or render the claimed invention obvious and withdrawal of the rejection of Claims 1-7, 9 10 and 12-15 under 35 U.S.C. 102(a) or 35 U.S.C. 102(e) over Shimomura et al. (U.S. 2004/0251809 or U.S. 7,189,340) is respectfully requested.

The rejection of Claims 1-7, 9 and 11-15 under 35 U.S.C. 103(a) over Jüstel et al. (U.S. 6,084,250) is respectfully traversed.

Jüstel describes a light-emitting device composed of a UV-diode and a phosphor layer containing a blue, green and red emitting phosphors. The Office cites the reference beginning in Col. 3, line 50, as showing Eu complexes having the same formula as according to the claimed invention. However, Applicants respectfully submit that Jüstel does not disclose or suggest that the red phosphor has a triclinic crystal structure and has a minimum emission intensity within the excitation wavelength range of 380 nm to 410 nm of 65% or more and an emission efficiency at 400 nm of 20% or more. Moreover, this reference provides no guidance with respect to method of preparation of the red phosphor. Therefore, it does not provide motivation that would have led one of ordinary skill in the art, at the time of invention, to the claimed invention. Accordingly, the cited reference cannot render the claimed invention obvious and withdrawal of the rejection of Claims 1-7, 9 and 11-15 under 35 U.S.C. 103(a) over Jüstel is respectfully requested.

Applicants herein submit a concise explanation of the relevance of the cited references in the IDS filed August 4, 2006.

The objection to the Abstract is believed obviated by appropriate amendment. An amended abstract (marked-up and clean copies) is attached to this Response. Withdrawal of the objection to the Abstract is respectfully requested.

The objection to the drawings is believed obviated by appropriate amendment. Amended replacement drawings are submitted herein. Withdrawal of the objection to the drawings is respectfully requested.

The objection to the disclosure of the specification is obviated by appropriate amendment. The specification is corrected as required by the Office. Withdrawal of the objection is therefore requested.

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Applicants have noted the Examiner's objection on page 3, lines 5-7, of the Official Action, dated October 10, 2008, regarding use of the word "blanket" vs. "blaket" on pages 10 and 30 of the specification. However, Applicants' copy of the specification states "blanket" consistent with the drawing. The specification indicated in pair for this application also does not show use of "blaket." Applicants will correct the application if the Examiner can clarify where such correction is necessary.

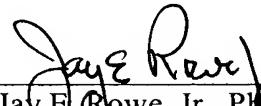
The rejection of Claims 6, 8 and 12 under 35 U.S.C. 112, first paragraph, is believed obviated by appropriate amendment. Each of these claims are herein amended to address the issue cited by the Office. Withdrawal of the rejection of Claims 6, 8 and 12 under 35 U.S.C. 112, first paragraph, is respectfully requested.

Applicants also note the Office's comment relative to the Information Disclosure Statement filed August 4, 2006, that a concise explanation of the relevance was not included. Attached hereto is a form concise explanation of relevance.

Applicants respectfully submit that the above-identified application is now in condition for allowance and early notice of such action is earnestly solicited.

Respectfully submitted,

OBLON, SPIVAK, McCLELLAND,  
MAIER & NEUSTADT, P.C.  
Norman F. Oblon

  
\_\_\_\_\_  
Jay E. Rowe, Jr., Ph.D.  
Registration No. 58,948

Customer Number  
**22850**

Tel: (703) 413-3000  
Fax: (703) 413 -2220  
(OSMMN 08/07)